Science Education International
Vol. 18, No. 4, December 2007, pp. 245-254

International Council of Associations in Science Education

Implementing "Science across the World" in a Resource-Based Learning Activity regarding Sustainable Development Issues

SHU-NU CHANG (shunu@ms3.url.com.tw), *College of Liberal and General Education, Aletheia University, Taiwan*

ABSTRACT *The rapid development of science and technology has become a global issue in modern society, since it will not only bring conveniences into people's lives but it may also cause extensive environmental damage to the planet earth. Therefore, it is important to propagate the notion of Science Technology and Society (STS) and the awareness of sustainable development. The purpose of this study was to implement a Science across the World (SAW) activity in a resource-based environment regarding two sustainable issues, "global warming" and "renewable energy," and to investigate students' responses to this SAW activity. Seventy-eight non-science major freshmen participated in the study. The results from participants' questionnaires indicated that students felt most interested in exploring ideas locally via Internet, and exchanging information with students from other countries globally. Through this activity, students also presented the positive results of the acquisition of knowledge, and they felt that their inquiry abilities got improved. Implication of STS teaching on students' learning and attitudes are discussed.*

KEY WORDS: *Resource-based learning, science across the world, STS, sustainable development.*

Introduction

Scientific literacy has been promoted for decades, whereas in the current science- and technology-dominated society, scientific literacy is considered as an important goal of science education. Generally speaking, scientific literacy is for enhancing individuals' scientific concepts, scientific attitudes and process skills towards science, and aims at increasing international competition and creating a well-being modern life. The rapid development of science and technology will not only bring a lot more conveniences into people's lives, but it also causes environmental damages affecting our planet in a detrimental way. Therefore, it is important to propagate the notion of *Science, Technology and Society* (STS) and to make people aware of sustainable development.

As the idea of STS was introduced earlier than the term of scientific literacy, the notion of STS and its relationship with the movement of scientific literacy will be initially delineated and then the goals of STS instructional design will be presented. In our Information Age, resource-based learning is also considered as an important learning approach that can have serious implications on teaching and learning science. The idea of resource-based learning will be also exemplified and how, in this study, it is linked to the activity of *Science Across the World* (SAW) will be clarified.

The Notion of STS in the Movement of Scientific Literacy

Cultivating and raising students' scientific literacy among the different disciplines became some decades ago the goal of science education worldwide (AAAS, 1993; DeBoer, 2000; Laugksch, 2000; MOE, 1998). The term scientific literacy has been used since the late 1950s, when Paul Hurd used it in a publication entitled "Scientific Literacy: Its Meaning for American Schools" (Laugksch, 2000). Literacy in science was always expected to improve individuals' life in a science- and technology-dominated society, and to promote international competition (Aikenhead & Ryan, 1992; Laugksch, 2000; Thomas & Durant, 1987). According to Laugksch's view (2000), the importance of scientific literacy has a macroscopic view implying that: (1) scientific literacy could lead to economic well-being of every nation and promote international competition; and (2) citizens possessing an appropriate level of scientific literacy will sustain the supply of scientists, engineers, and technically-trained personnel steady. The promotion of scientific literacy can also contribute to the intellectual culture itself (DeBoer, 2000; Shortland, 1988). In contrast with this macroscopic view, scientific literacy could also enhance an individual's life as well. Thomas and Durant (1987) expressed the idea that scientific literacy can improve an individual's living in a society by providing help in making personal decisions concerning diet, smoking, vaccination, and screening programs of safety in the home and at work.

In addition to the well-known concepts regarding scientific literacy, the awareness of STS has also been emphasized even before the term of scientific literacy was coined. From Deboer's review with regard to the historical perspective of scientific literacy (2000), it is not hard to trace the development of STS. He stated that the National Society for the Study of Education (NSSE) published its Forty-sixth Yearbook in 1947 entitled *"Science Education in American Schools."* This book made a special reference to a 1945 report of the Harvard Committee on General Education concerning the appropriate education of students at the elementary and secondary school level. The report pointed out that science instruction in general education should be mainly characterized by broad integrative elements, and that students need to know the relationship of science with problems of human society. The Yearbook Committee expressed the notion that scientific developments also have the potential to destroy society. Thus, the public need to have the appropriate knowledge and the necessary skills to make rational judgments about any risks associated with science, and that this need alone justifies why to teach science.

However, the concept of STS was still seldom noticed until the 1970s. Scientific literacy was more strongly identified with science in its social context throughout the 1970s and early 1980s (DeBoer, 2000). Gallagher (1971) pointed out that "For future citizens in a democracy, understanding the interrelations of science, technology, and society may be as important as understanding the concepts and processes of science" (p. 337). In 1982, the NSTA board of directors adopted a statement entitled: *"Science-Technology-Society: Science Education for the 1980s."* In this statement, the goal of science education was to breed scientifically literate individuals who could understand how science, technology, and society influence each other, and who are able to apply this kind of knowledge into their everyday decision-making (DeBoer, 2000). The last important attempt to promote STS

relates to Project 2061, which suggested that individuals should correctly conceptualize that science, mathematics, and technology are human enterprises, and that people should also understand what this implies about their strengths and limitations (AAAS, 1989).

To achieve the goal of scientific literacy, teachers and science educators should concentrate on the design of instruction for student learning and on the evaluation of student performance (Aikenhead & Ryan, 1992; Champagne & Newell, 1992; Jenkins, 1992; Laugksch, 2000; Laugksch & Spargo, 1996). For cultivating scientific literacy, the instructional design of STS is also emphasized in science education. Fundamentally, comparing STS science teaching to traditional science teaching, STS science teaching is student-oriented and it is also expected to increase general interest in and public understanding of science, particularly for the bright and creative students, who are discouraged by a boring and irrelevant curriculum (Aikenhead, 1994; Solomon, 1988). Bybee (1985) stated that the balance for STS science education relates to three general goals encompassing the acquisition of knowledge for personal matters, civic concerns, and culture perspectives (concepts within, and concepts about science and technology). Thus, STS science education targets the development of learning abilities for information gathering, problem solving, and decision making (processes of scientific and technological inquiry), and the development of values and ideas for local issues, public policies, and global problems (dealing with interactions among science, technology, and society). Based on the goals stated by Bybee (1985), the sustainable development issues of SAW and the activity conducted in this study fit nicely with the goals of STS.

Resource-based Learning and the Idea of SAW

The current modern society is full of complex knowledge and information resources, especially as more and more information is stored and presented electronically all over the world. Therefore, the most popular resource people use for searching information is the Internet. As using the Internet becomes a major trend, resource-based learning gained momentum as an important learning model for schools. At the same time, there has been an increasing emphasis on students' learning to become self-regulated as they interact with a wide range of learning resources (Neumann, Gräber, & Tergan, 2005; Rakes, 1996). Resource-based learning has thus become more important in the Information Age. Briefly, resource-based learning implies examining a topic and locating the information to answer questions or to solve problems related to this topic (Rakes, 1996). According to Rakes' statement, information resources could include print and non-print media, ranging from books/articles to sound/video recordings, and to electronic databases or other computer-based resources. Today, the Internet is the prevalent medium of the information resources, and it provides the means for reinforcing instruction and learning in a resource-based learning environment. Some of the benefits from using the Internet relate to Internet affordances to engage students as active participants in learning and help some people participate more easily, learn more effectively, and enjoy their learning more. The Internet can also provide both teachers and students with an ever-growing and rapidly expanding source of information (Hargis, 2001).

Resource-based learning can be also illustrated as a learning model where

students learn from their own interaction with a wide range of information resources rather than from conventional class exposition (Brevik & Senn, 1994; Rakes, 1996). The resource-based learning model emphasizes the following six points:

- Teacher becomes the facilitator/guide of students' learning
- Students use a variety of sources/media
- Questions are the primary tools in learning
- Information is not disseminated, but it should be discovered
- More emphasis is put on the process of learning
- Assessment becomes both quantitative and qualitative

SAW is a Web-based environment supported by the Association for Science Education (ASE), which offers students opportunities to globally exchange information and ideas on a variety of science topics (Cutler, 2004). With regard to the idea of SAW that welcomes the meaning of resource-based learning, the Internet is the main resource that students can use to search for relevant information.

In the present study, the resource-based learning model was embedded in the instructional design. The purpose of the study was to link SAW activity in a resource-based environment regarding two sustainable issues, "global warming" and "renewable energy," and to investigate students' feedback about this activity. The study attempted to investigate (1) students' feedback about the acquisition of knowledge through SAW activity; (2) whether students felt that their abilities have been improved through SAW activity; (3) whether students felt that the global exchange through SAW encouraged them in this learning activity; and (4) what was for students the most interesting part in the SAW activity.

Methodology

Participants and the Learning Context

The sample used in this study consisted of 78 non-science major students. The participants were all freshmen and came from two departments, the Religion department (36 students) and the Language department (42 students). The SAW activity was conducted in a required course called "Introduction to the Nature of Science." Students were expected to complete this course for their graduation, and the course is usually scheduled for freshmen level. This course relates to sustainable development and the content of the instruction should always target an appropriate conceptualization of sustainable development. Besides this SAW activity, there are three other topics linked with the course. Specifically, these topics are "Chemistry in our lives," "The story of the brain," and "Biotechnology in the modern life." Concerning the SAW activity, renewable energy and global warming were the two topics that students were requested to explore and present orally in class.

With regard to the implementation of the SAW activity, the instructor initially provided the background of SAW and pointed out the importance of the two topics regarding renewable energy and global warming. Then, each student was asked to become a member in a group and work with a team. Meanwhile, the instructor

made clear to students what kind questions they should explore locally in the next six weeks (the questions came from student's notes provided by SAW Website). The instructor also offered several research reports with regard to the same questions that were investigated by students from other countries. Lastly, students needed to present in class their results as surveyed locally, and to also discuss the results from other countries.

The Development of Questionnaire and Data Analysis

From the process of SAW activity, students were expected to learn more English vocabulary, because the reports from other countries were all in English, and students were also instructed to write their reports in English. Students were also expected to construct correct conceptions about renewable energy and global warming. Moreover, students' abilities to search for relevant information, to communicate with team members, to critically think, and to implement plans smoothly and efficiently were expected to be improved as well. Based upon the globalization in current society, it was finally expected that through the SAW activity students should open their eyes and feel closer to other countries' problems.

To find out whether the stated goals had been achieved, the questionnaires were administered at the end of the activity. Since, it was not a language course, English ability was not tested in this study, and only Likert scale items were developed for probing students' feedback after participating in the SAW activity. The degree of acceptance was from "disagree strongly" to "agree strongly" and scores from 1 to 7, as it is indicated in Table 1, were accordingly assigned. A total of 13 items were developed in this questionnaire, and the items were grouped into four dimensions corresponding to the four research questions. The validity of the questionnaire was confirmed using expert judgements, and alpha reliability of the 13-items questionnaire was found to be 0.89.

Table 1
The Scoring of the Degree of Acceptance for Each Item

Degree of acceptance	Agree strongly	Agree	Agree a little	No opinion	Disagree a little	Disagree	Disagree strongly
Scores	7	6	5	4	3	2	1

Results

The results indicated that students were really interested to investigate renewable energy and global warming in a resource-based learning activity. Generally speaking, the participants, who were non-science students, felt interested in taking part in the study and could easily discuss topics related to sustainable development. The total score regarding their acceptance was 5.44 on average. The detailed results are presented as follows.

Students' Feedback about the Acquisition of Knowledge

In terms of knowledge acquisition, students felt that the SAW activity improved their understanding of issues related to sustainable development (Mean=5.83, *SD*

= 0.76) and benefited their learning about science-related concepts (Mean=5.78, *SD* = 0.86). Students also felt that, after experiencing the SAW activity, they became more interested in exploring science-related knowledge by themselves in the future (Mean=5.28, *SD* = 1.05). The lowest score on this dimension appeared in the item where students were asked to state whether the discussed issues were the most interesting part of this SAW activity. The acceptance score was on average 4.76 (*SD* = 1.09). Table 2 shows the items of the questionnaire and descriptive statistics on students' performance.

Table 2
Students' Feedback about Concepts Learning

Items	Mean	SD
1-1 SAW improved my understanding of issues related to sustainable development	5.83	0.76
1-2 SAW helped me to learn science-related concepts	5.78	0.86
1-3 I will like to explore science-related knowledge by myself in the future after SAW activity	5.28	1.05
1-4 The discussed issues were the most interesting part from SAW activity	4.76	1.09
Total	5.41	0.94

Students' Feedback about the Improvement of Their Abilities

Students felt that their abilities had been improved from the activity and most students agreed that their abilities were greatly enriched after this learning activity, as indicated in Table 3. The ability of information-searching scored highest (Mean=5.74, *SD* = 0.82), while students also felt that their ability of communication had been also enhanced (Mean=5.57, *SD* =1.05), since teamwork was required for this learning activity. Students also stated that their ability to think was stimulated through the SAW activity (Mean = 5.51, *SD* = 0.90) and that their ability of implementing a plan improved after this learning experience (Mean=5.38, *SD* = 0.98). They attributed the improvement of their ability to implement a plan to the complexity of the task they had to complete. Students needed to finish many things in six weeks and discuss the questions from the students' notes provided by the SAW Website. They were also requested to study and present the information offered by other countries.

Table 3
Students' Feedback about the Improvement of Their Abilities

Items	Mean	SD
2-1 SAW improved my ability of information-searching	5.74	0.82
2-2 SAW improved my ability of implementing my plan	5.38	0.98
2-3 SAW improved my ability of communication	5.57	1.05
2-4 SAW stimulated my ability of thinking	5.51	0.90
Total	5.55	0.93

Students' Feedback about Global Exchange

Regarding globalization, students stated hat world distance has been shortened via the SAW activity, as indicated in Table 4. Students thought that the SAW activity made them feel closer to other countries, even countries as far away as Europe (Mean=5.29, *SD* =1.29). In addition, non-science majors in this study also felt like studying the viewpoints from other countries (Mean=5.47, *SD* =1.02). It was also clear that global exchange was for students the most interesting part of the SAW activity (Mean=5.73, *SD* =0.96).

Table 4
Students' Feedback about Global Exchange

Items	Mean	SD
3-1 SAW made me feel closer to other countries worldwide	5.29	1.29
3-2 It was helpful for me to have the viewpoints from other countries through SAW	5.47	1.02
3-3 Sharing their opinions with other countries was the most interesting part of this SAW activity	5.73	0.96
Total	5.49	1.09

Students' Interests in the SAW Activity

To sum up the learning interests regarding this activity, the results were positive, as indicated in Table 5. Students expressed clearly that the SAW activity promoted their learning interests and motivation to learn (Mean=5.24, *SD* =0.96). In addition, students expressed an interest to be involved in the same activity in the future (Mean=5.06, *SD* =1.28).

Table 5
Students' Interest in SAW Activity

Items	Mean	SD
4-1 SAW promoted my learning interests and motivation to learn	5.24	0.96
4-2 I would like to participate the same activity in the future	5.06	1.28
Total	5.15	1.12

The Benefits for the Lower-achieving Students

Moreover, the differences between the two classes of students regarding the scores of acceptance were investigated. The results indicated that the scores of acceptance were higher in the group of students from the Religion department, as indicated in Figure 1. The average of acceptance scores was 5.51 from the Religion department and higher than the corresponding value from the Language department (5.37). Only in the item 1-2 (Mean=5.88/5.66), item 2-2 (Mean=5.40/5.36) and item 2-3 (Mean=5.71/5.41), students from the Language department scored higher than students from the Religion department, but the overall differences were not significant.

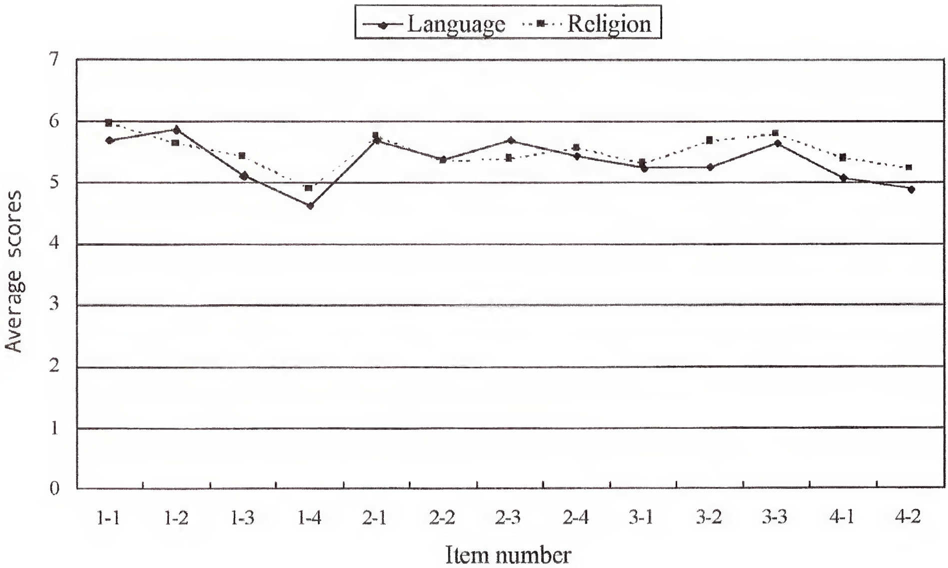

Figure 1. The Differences between the Two Classes

Conclusions and Discussion

The results of the present study clearly ubdicated that issues related to sustainable development-related became globally interrelated and important. Therefore, it is important to propagate the notions of sustainable development, and STS instruction needs to be emphasized in education as well. In this study, after non-science majors participated into the SAW activity regarding the issues of renewable energy and global warming in a resource-based learning environment, they felt interest in these sustainable development issues and the whole SAW activity. Concerning the three goals of STS instruction mentioned by Aikenhead (Aikenhead, 1994), students expressed the idea that this SAW activity helped them to progress towards achieving these goals. In terms of acquiring knowledge, students felt they were able to learn science-related concepts, and became interested in exploring other scientific knowledge in the future. These beliefs seem to be a good start for non-science majors' life-long learning about science. In terms of the development of learning abilities, students also thought their abilities regarding information-searching, communication, implementation, and thinking have been well enhanced. Lastly, from the global exchange process, students developed values and ideas locally and worldwide with regard to global problems.

From their overall ideas, students appeared to enjoy their participation in this activity and would also like to participate in similar activities in the future. In addition, it was also clear that students from the Religion department enjoyed this activity more than students from the Language department. These results seem to support evidence from other studies indicating that STS science teaching increases learners' general interest in and public understanding of science (Aikenhead, 1994; Solomon, 1988). In reality, most students from the Religion department did not have enough self-confidence to be engaged in this SAW activity, and their scores on the university entrance exams are usually lower than the scores of

students from the Language department However, the students from the Religion department enjoyed the activity more than the students from the Language department and finally became as confident as the students from the Language department to undertake by themselves similar activities.

Implications relating to STS Teaching

Regarding the implications of STS instruction, global exchange seems to be a good idea and the SAW activity contributed to achieving this goal, which is not only to fit with the trend of globalization, but also to promote students' interest in science learning. Cutler (2004) stated that global exchange was the most attractive part of SAW activity for his students, as it was also for the students of the present study. Comparing the discussed issues and the global exchange process of SAW, students felt more interested in the global exchange part of SAW. Besides, adopting teamwork to STS instruction is also a good strategy to make students learn how to collaborate with other members and how to manage their progress. Students can also improve their abilities via the natural interaction with other bright students. Moreover, providing guidelines for students to investigate STS-related topics is an effective approach in STS science teaching and fits well with the resource-based learning model (Rakes, 1996). In conclusion, this study provided a good STS instruction experience through embedding SAW activity and the resource-based learning model into non-science majors' science classes.

References

AAAS. (1989). *Science for All Americans.* Washington, D.C.

AAAS. (1993). *Benchmarks for Science Literacy.* Washington, D.C.: American Association for Advancement of Science.

Aikenhead, G. S. (1994). What is STS Science Teaching? In J. Solomon and G. S. Aikenhead (Eds.), *STS Education: International Perspectives on Reform* New York: Teachers College Press.

Aikenhead, G. S., & Ryan, A. G. (1992). The development of a new instrument: "views on science-technology-society" (VOSTS). *Science Education,* 76(5), 477-491.

Brevik, P. S., & Senn, J. A. (1994). *Information literacy: Educating children for the 21st century.* New York: Scholastic Inc.

Bybee, R. W. (1985). The Sisyphean question in science education: What should the scientifically and technologically literate person know, value and do – as a citizen? In R. W. Bybee (Ed.), *Science- technology-society. 1985 NSTA Yearbook.* Washington, D. C.: National Science Teachers Association.

Champagne, A. B., & Newell, S. T. (1992). Directions for research and development: alternative methods of assessing scientific literacy. *Journal of Research in Science Teaching, 29(8),* 841-860.

Cutler, M. (2004). Exploring science locally and sharing insights globally. *School Science Review, 86*(314), 33-41.

DeBoer, G. E. (2000). Scientific Literacy: Another look at its historical and contemporary meanings and its relationship to science education reform.

Journal of Research in Science Teaching, 37(6), 582-601.

GALLAGHER, J. (1971). A broader base for science teaching. *Science Education, 55*, 329-338.

HARGIS, J. (2001). Can students learn science using the Internet? *Journal of Research on Computing in Education, 33*(4), 475-487.

JENKINS, E. W. (1992). School science education: Towards a reconstruction. *Journal of Curriculum Studies, 24*(3), 229-246.

LAUGKSCH, R. C. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*, 71-94.

LAUGKSCH, R. C., & SPARGO, P. E. (1996). Development of a pool of scientific literacy test-items based on selected AAAS literacy goals. *Science Education, 80*(2), 121-143.

MOE. (1998). *1-9 grades curriculum guidelines.* Taipei: MOE.

NEUMANN, A., GRÄBER, W., & TERGAN, S.-O. (2005). Paris - Visualizing ideas and information in a resource-based learning scenario. In S.-O. Tergan & T. Keller (Eds.), *Knowledge and Information Visualization* (pp. 256-281). Verlag Berlin Heidelberg: Springer.

RAKES, G. C. (1996). Using the Internet as a tool in a resource-based learning environment. *Educational Technology, 36*, 52-56.

SHORTLAND, M. (1988). Advocating science: Literacy and public understanding. *Impact of Science on Society, 38*(4), 305-316.

SOLOMON, J. (1988). Science technology and society courses: tools for thinking about social issues. *International Journal of Science Education, 10*(4), 379-387.

THOMAS, G., & DURANT, J. (1987). *Why should we promote the public understanding of science?* Oxford, UK: University of Oxford.